E/CONF.39/D/83
10 Oct.1962
ORIGINAL : ENGLISH

UNITED NATIONS CONFERENCE
ON THE APPLICATION OF SCIENCE AND TECHNOLOGY
FOR THE BENEFIT OF THE LESS DEVELOPED AREAS

Agenda Item:D.1

Poland

THE CHOICE OF TECHNIQUES IN DEVELOPING COUNTRIES

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THE CHOICE OF TECHNIQUES IN DEVELOPING COUNTRIES

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1. The improvment in living conditions of milions of inhabitants of developing countries depends in the first place on the rate of growth of national income in those countries. This in turn depends on one hand upon the level of investment, i.e. upon the share of accumulation in total income, and on the other - upon the effectiveness of this investment.

2. Since resources at the disposal of developing countries are scarce, the problem of their optimal allocation becomes essential. It consists in selecting the best from the point of view of the countries needs - physical structure of investments and in choosing for separate industries such production techniques, which assure the greatest results from given inputs.

3. The problem of the choice of production techniques concerns in particular the question, whether it is expedient or not to apply in developing countries such production techniques which are used in countries having a high level of development /i.e. highly capital-intensive techniques/.

4. Until the early fifties the prevailing opinion was that in conditions of developing countries which have serious labour surpluses and relevant lack of capital, production technique must differ from techniques used in those countries, which have large capital stocks and relatively few unemployed. In recent years, however, the opposite opinion gains more and more supporters[x]. Before expressing our own opinion we will present in short the state of discussion concerning the subject.

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5. Considering the level of output /P/ in relation to employment, it can be said, that it depends on the ammount of employed /L/ and the labour productivity /W/. Thus the equation is obtained:

$$P = L \cdot W$$

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x. I.a.: H. Leibenstein, W. Galenson, A. Kosen, M. Dobb, and R.H. Bettelheim.

6. This leads to the conclusion that having a certain investment fund we may obtain the increase of production either by employing additional workers having the same labour capacity /that is to say employed in the same traditional technique/, or by increasing the productivity of workers already employed through improving or increasing their equipment, that is to say by introducing a new and more modern technique.

7. Which of those two ways is better, can not be teremined a pri ori, since this depends on how labour productivity will change owing to changes in equipment.

8. Let us assume that a given investment fund would lead - in conditions if traditional technique - to increase employment / and therefore also production / by a certain percent. If the same increase of efficiency ... btained when this fund is used to increase equipment per worker, then from the point of wiew of the level of production the choice of technique is irrelevant. But if the increase of efficiency will be relatively grater, then it will be expedient to invest more intensive techniques and if it will be smaller, than traditional techniques increa... ...ployment should be applied. Of course in every field of production and even in each industry relation between changes of equipment a... changes of efficiency will be different. Simplyfying the question, it can be assumed, that if at the starting point equipment per employed is very low, then its increase will lead to a more than proportional growth of efficiency, after however a certain ceiling of efficiency has been reached, it will grow slower than equipment.

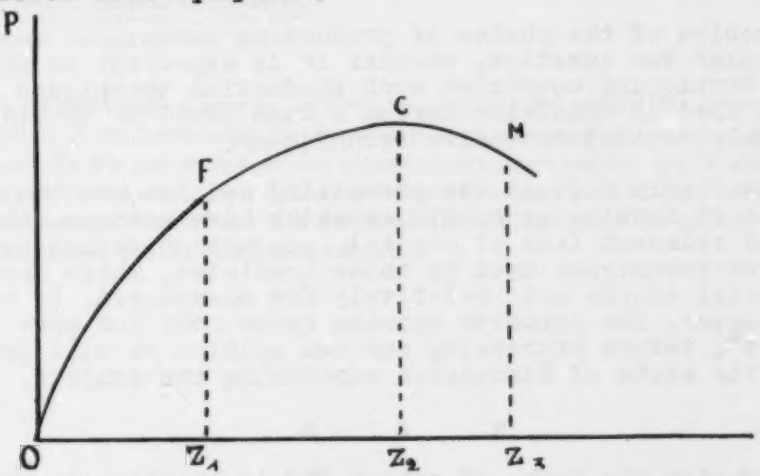

Figure I.
/taken from A.K. Sen's book "Choice of Techniques" Oxford 1960/

9. The problem discused above is shown in Fig.I, where the level of employment has been presented on the horizontal axis and the level of production on the vertical one. Having a definite invest ment fund, a different ammount of workers can be employed, depending on the technique chosen. /Since the total investment fund

is given, the ammount of equipment per worker will be in inverse proportion to the ammount of employed, that is to say, the abciss will present at the same tume the level of employment and the inverse of the intensity of separate techniques. In the same way the vertical axis presenting the level of production obtained from a given investment fund will express the inverse of capital intensity of output attained with separate techniques. If very scarce equipment per worker is used we can employ Z_3 workers, whose output level will be MZ_3. But if we choose modern technique where more equipment per worker is needed, then the productivity of workers [illegible] so that although the ammount of employed will fall to the point Z_2, the total ammount of production will be higher. If techniques still more intensive are used, then though productivity per worker will be increasing, this increase will be slower than the growth of intensity of techniques or else of the fall of employment, so that eventually total produstion will be smaller than before.

10. It is obvious, zhat transition from technique M to technique C is worthwhile in any conditions, because with a given investment outlay and smaller employment, higher output will be reached. What kind of argument, however, could induce investors to use not the technique C but F at which the level of output attained from a given investment fund is smaller? The reason can be only that labour force is too scarce to assure the use of technique C.

11. Those who advocate the use of less intensive techniques in developing countries than in the developed ones, have usually this case in mind. They point out, that in industrialized countries tha lack of labour hands leads to substituting to a large scale capital for labour in spite of the decreasing effectiveness of investment. In less developed countries it is not necessary to use such intensive methods, sonce the labour reserve is sufficient for techniques, which maximise production.

12. Those who are of different opinion do not deny this fact. They stress however, that direct maximisation of output /and also of national income/ can not be an objective in itself, since the planners in developing countries must in the first place take into account the highest possibly rate of longterm economic growth Once this is considered, additional factors come into account, which in their opinion discredit techniques maximising production

13. They point out namely that the choice of production techniques at any given level of real wages determins not only the efficiency of investment but also the share of accumulation in national income.

14. This can be seen on Fig.2, where the line OR is introduced

to show the level of the wage fund. If constant real wages are assumed[x], the line OR will be straight, since the wage level will grow in proportion to the ammount of employed. It can be seen from the Figure, that if technique C is applied, which maximises production, then the wage fund /which in our example is taken as eqiuvalent to social consumption/ will comprise a large part of total output. The size of the investment surplus, that is to say of this part of total production which is left after substracting the share consumed by the workers, will in this case be lower, than when technique F is chosen. Thus there is a contradiction between technique maximising the immediate production and technique maximising the investment surplus, that is to say, assuring the highest long range growth rate of the economy when the initial investment fund is given. This contradiction results of course from the fact, that transition from more capital intensive techniques to less capital intensive ones leads to gradual decrease of efficiency per worker. If the average real wage is kept at a constant level, this efficiency must fall to the point where the ad ditional product produced by a worker will not be equivalent to his real wage. In such a case the total production level will be rising since the worker produces a certain ammount of output/, and simultaneously the surplus will be falling /since he comsumes more than he produces/.

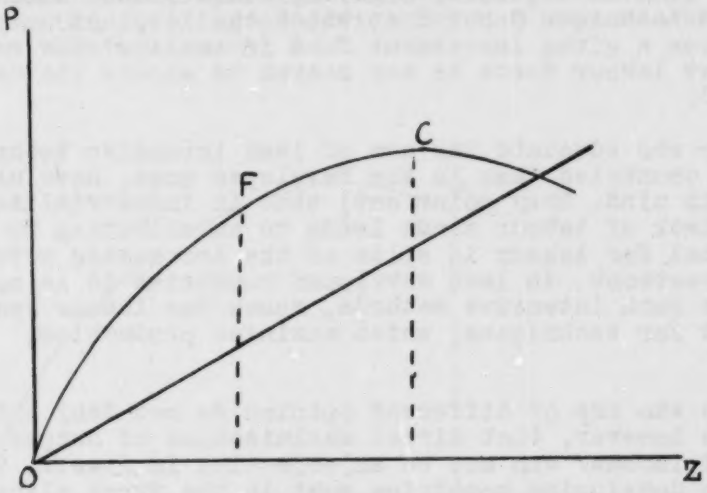

Figure II.
/taken from A.K. Sen's book "Choice of Techniques", Oxford,1960

15. It should be pointed out that the choice between techniques maximising output and techniques maximising the surplus does not

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x. This is a simplified assumption, since as a matter of fact real wages will fall during the transition towards less intensive techniques which however will not change the essential interrelations considered here.

essentially concern private investors. Small, independent producers tend, as a rule, to maximise production, dividing it later in a certain proportion between consumption and investment. A capitalistic entrepreneur will always tend to apply techniques maximising the surplus, since, if he did not so, his profit /which is nothing else but this surplus/ would be smaller. The contradiction presented above can also have no greater practical influence on investment decisions of the planning authorities in developed socialist countries, where full employment has been reached, since in those countries the limitted ammount of free labour force compels to use highly capital intensive techniques, even if those techniques do not maximise production or surplus. But in developing countries, which have a great number of unemployed, where introducing both kinds of techniques is feasible and planning is aimed to a quick rise of social consumption and to assure an adequate rate of growth of national income in the long run, the dilemma, at least from the theoretical point of view, exists.

16. It seems, however, that its importance has been much exaggerated in recent discussions owing to the fact, that a number of elements has not been considered. Those elements on one hand diminish the contradictions mentionned and on the other - they limit seriously the freedom of choice of planning authorities concerning various production techniques. Let us now consider some of those factors.

17. What has been stated above ammounts to saying that each technique of production has a double effect on national income. The direct effect consists of an immediate but single increase of the production capacity and of the production level. Moreover, there is also an indirect long run effect: the technique of production through its influence on income division determines the share of accumulation in national income and to that extent the rate of growth of this income.

18. Techniques aiming at maximising output provide a big direct effect, while their long run effect is small. Techniques maximising the surplus lead to opposite results. Adherents of this second solution argue that slow initial increase of national income, resulting from applying such techniques, is compensated for in relatively short time by a higher rate of growth of income during following years. This is true under the assumptions which they introduce. If the planning authorities have at their disposal a certain investment fund, and if the rate of growth of national income in the following period depends exclusively on the size of the investment surplus resulting from that "initial" fund, then society choosing techniques which maximise the surplus has to restrain from current consumption for a relatively short period of time. A relatively small direct increase of production resulting from that technique is the price which must be paid in the first period. But in all following periods /let us call them "years" assuming that one year elapses starting on an investment project and obtaining its first production effects/, the highest possible rate of growth of national income will be reached/.

That is why in a relatively short time the difference resulting from a lower starting point can be overcome and in the following periods society has at its disposal a higher income, which is growing faster than it would be the case under any other technique. /Thus, if we assume e.g. that the initial investment fund is 1000, and that it provides additional output of 400 if the surplus enables a rate of growth of 2% or additional output of 350 if the surplus enables a rate of growth of 3,5% then the difference of income levels will be balanced already after 9 years if technique maximising the surplus is chosen.

19. Does this mean in fact that technique maximising the surplus always assures the highest rate of growth of the economy as a whole? This was the opinion of those who advocated "surplus maximisation" identyfying tacitly or explicitly the initial investment fund with the total investment fund which is at the disposal of the economy. They assumed, that the investment process starts with the shift of a certain surplus taken from the subsistance sector of the economy, and that the future rate of growth of the economy depends of the economy exclusively on the ammount of resources originating from this initial fund, since the state has no additio nal accumulation funds.

20. This image however is very far from reality[x]. In no country of the world the state development program started from a "tribute" taken once from the population and dependent further exclusively on the "investment surplus" reached from this "tribute". Every modern state has some constant incomes, and a part of those incomes can be each year allocated for accumulation. They come from taxes levied on the population and on private enterprises, domestic or foreign, and especially from "royalties" In those countries, where land reform has been passed, the state takes over a part of the rent previously due to landlords. Finally, it can dispose of incomes coming from state-enterprises which have been either created earlier by the state, or nationalised recently. Income coming from those enterprises is fixed and independent from current investment policies, since it depends upon existing capital equipment of those enterprises.

21. The beginning of public industrialisation consists of allocating a part of those incomes for accumulation. Let us assume that in year 0 the state puts aside a certain part of its incomes, creating thus an "initial investment fund" and allocating this fund to production techniques which maximise the surplus. In the following years a relatively small increase of national income will be reacged, but also there will be a certain surplus coming from investments realised during year 0 which we shall call "the dependent" investment fund. / It is dependent in the sense that

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x. The second part of this paper is based on a large extent on ideas put forth by professor M. Kalecki during his lectures in Spring 1961 at the High School of Planning and Statistics.

its size depends on the choice made by the state in the field of production techniques appied to new investments. But this dependent investment fund is not only fund at the disposal of the state, since contrary to theoretical assumptions on which we have been basing thus far, the state is allocating to investment purposes the same ammount of current budget incomes as before. This part can be called the "independent investment fund", independent in this sense that it is determined externally and its size does not depend on any current investment policy. Will the state assure the highest rate of growth of national economy allocating both those funds to techniques maximising the surplus, as it was the case before?

22. This is not so certain. This technique will assure the highest rate of growth of the part of income which is produced from the "dependent" investment fund, simultaneously however, it will slow down the increase of income obtained from the independent investment fund. As this last fund will be invested in the second year only the direct effect of technique maximising the surplus, namely a small increase of production, will manifest itself. A similar situation will occur in year 3 and it will be repeteade as long as besides the "dependent" investment fund there will be an "independent"one. In other words if we once assume, that the initial investment fund is not a stock but a flow, then it is obvious, that the price, consisting of a small increase of income in the forst period, which under simplyfying assumptions the society had to pay once, must, as a matter of fact, be paid every year, since every year a part of the total investment fund provides a smaller increase of income, than would be the case if it was invested in techniques directly more effective.

23. Those relationships can be presented by the following equation where national income = Y, dependent investment surplus = E, independent investment surplus = K capital output ratio of investment = m /capital output ratio of investments connected with technique maximising the surplus = m_1 and the same connected with technique maximising output = m_2, so that $m_1 > m_2$ /.

$$\frac{\Delta Y}{} = \frac{R}{Y} \cdot \frac{1}{m} + \frac{K}{Y} \cdot \frac{1}{m}$$

24. When the initial investment fund is given only once, then the above equation has only one term, and it is obvious that it will be maximised by m_1 /since m_1 . R give ex definitione the highest rate of growth/. Since m_1 it must be assumed that it is constant flow, the second term of the equation must be taken into consideration and then no answer a priori can be given, whether maximising the rate of growth is connected with technique m_1 or m_2, since the forst one maximises the first, and the second maximises the second expression.

Whether: $\frac{R}{Y} \cdot \frac{1}{m_1} + \frac{K}{Y} \cdot \frac{1}{m_1} \gtrless \frac{R}{Y} \cdot \frac{1}{m_2} + \frac{K}{Y} \cdot \frac{1}{m_2}$

can not be determined as long as the size of K and R and the interrelation between m_1 and m_2 are not known. It is known however, that at the starting point of the state development program R must be small /in the first year it ammounts to 0/ and thus the rate of growth of income will depend in the first place on K, that is to say, it will be the greater, the higher is the immediate efficiency of chosen techniques. As time goes on, the situation will change, since R will rise. /Because every year it will increase by the surplus obtained from K invested in the previous year/. Thus after a certain time it is this figure that will be determing the rate of growth of the whole income.

25. This will happen earlier or later depending i.a. on the origin of K. If the independent investment surplus will be coming from enterprises which were state owned before the investment program has been started, then its overall size will be fixed, and this of course will cause R to exceed K at an earlier moment. But if K will come from taxes levied on the private sector, then its overall size will be increasing together with the growth of national income and thus the moment at which R exceeds K will come later although sooner or later it must come because R increases faster than national income as long as there is an independent surplus.

26. As can be seen, the fact that actually the initial investment fund is not a stock but a flow does not change in an essential way the fact, that in the long run the rate of growth of income will be maximised by techniques which maximise the investment surplus. It introduces, however one essential change into the reasonning, namely that this maximisation of the rate of growth will not start immediately, but only after a certain time, and also that society will have to pay the costs of this policy for a much longer time than was previously assumed.

27. Thus in the example presented before, techniques maximising the surplus will bring results already after nine years. But if we assume that the initial investment fund is not given once, but that it is a flow ammounting every year to 1000, then such results will be reached only after 17 years. If we accept that this flow will be growing together with national income, what is closer to real conditions, the period under consideration would ammount approximately to 2o years.

28. It seems that this change of the time horizon during which positive effects of techniques maximising the surplus will appear can have great significance for economic planning in developing countries. Although the objective of state policy should be to assure long range economic growth, neverthless it is obvious that growth should be visible as quick as possible. Under the present extremely low living standarts in developing countries, it is absolutely impossible, for social reasons, to postpone for a long time the rise of consumption. This can also be impossible for political reasons, since it is easier to induce

the population to accept a program which will begin to yield gains after 10 years, than to obtain its approval of a policy which will bring effects after 20 years, and therefore benefit in principle t the next generation.

29. There is another factor which must be taken into account when the planning authorities decide on production techniques which are necessary from the point of view of the rate of growth of national income, and this is technical progress.

30. Thus far, we have assumed constant techniques: differencies on effectivness, but this effectivness was constant in time, and therefore the share of the investment surplus in national income was also constant as well as the rate of growth of income.

31. In real conditions however technical progress leads to a rise of labour productivity of workers employing a definite technique, and thus total output is rising. Under the assumption of fixed real wages /[illegible]sary when there is serious unemployment/, the wage-fund does not change, and therefore the surplus itself as well as its share in income are rising. This leads to accelerated growth of national income.x

32. Thus the reinvestment of the surplus leads under technical progress /the impact of which can not be omitted in long range planning/ not to a constant, but to a raising rate of growth of national income. Although this does not influence the fact that maximising the surplus is equivalent to maximising the rate of growth / if independent sources of accumulation in the sense determined above are not taken into consideration/ it does however in a sense diminish its practical influence. It is obvious that under those circumstances the planning authorities in underdeveloped countries are not compelled to such an extent to maximise the surplus by introducing capital intensive methods of production. On the other hand the problem of raising employment as well as social consumption as fast as possible becomes more urgent, and this is connected with production methods which are not so capital-intensive.

33. Thus far only total production was considered, under a tacit assumption, that the structure of output /its division between producer and consumer goods/ depends on decisions of the planning authorities which choose some definite technique.

34. Actually, however, the question is not so simple. In some branches of the economy, output can not be shaped at will by the mere level of investment allocated to those branches. In the first place agriculture should be mentionned as such a branch. In less developed countries institutional factors prevailing in agricultur and a low level of technological ~~fx~~ skill among the farmers determin a very stiff ceiling on the growth of output, so that planners must assume that the rate of growth of agricultural production is independent of investment policies, at least in shorter time periods. On the other hand the rise of the wage-fund leads to an

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x. This acceleration will last as long as there is free labour force.

exceptionally sharp rise of demand for food. The assumption of constant real wages is equivalent in those conditions to the assumption, that the rise of the total wage-fund connected with the rise of employment resulting from the investment program, will not be greater than the increase of the market food supply refered to further as "the food surplus"

35. In those conditions the size of the food surplus will determine the possible intensity of techniques, when the investment fund is given. Intensity of techniques thus determined is not necessarily the same as the one which would be optimal in conditions of complete elasticity of food supply. On the contrary it is very possible, that planners will be forced to choose techniques which are more intensive, than the case of"optimal" choice.

36. Thus the food surplus limiting the growth of employment im developing countries influences decisions concerning the choice of techniques in a similar way, as full employment in highly developed countries. In both cases the rate of growth of employment is usually smaller than the rate of growth of accumulation / it is determined by the "external" rate of growth of the food surplus in underdeveloped countries, and by the "external" rate of growth of the population in developed ones. This leads to the necessity of using intensive techniques, even at the cost of raising the capital output ratio.

37. It should be stressed however, that although the food surplus in developing countries is usually inelastic in relation to investment, this does not mean that it is also inelastic in relation to other means of economic policy, influencing technical and structural limits of agriculture. Certain institutional reforms as well as intensive professional training of farmens may lead to greater elasticity of the food surplus.

38. The above remarks do not of course pretend to be a complete presentation of the problem of choice of "optimal" production techniques in developing countries. They were only aimed at pointing out some aspects of this problem,,omitted sometimes in thepretical discussions which in the authors opinion are of great importance for practical planning. The conclusions are not homogenous. It seems, on the one hand, that in developing countries there is a certain limit of growth of employment which is not very far from the limit determining the choice of techniques in highly developed countries. On the other hand, however, if this limit is not taken into consideration, then production techniques used in highly developed countries do not seem as expedient as they would appear in the light of the arguments of the partisans of the highest technique.

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